



centre de
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*pour la formation générale
en science et technologie*

Because anyone **can** learn to formulate hypotheses!



GUIDE

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Thanks to

For her eyes and advice in terms of didactic elements, Marie-Noël Bety, professor in didactics for science and technology, Université de Montréal

For linguistic review, in French:

- Lucie Brouillette

For English translation :

- Christine Tansey

Note:

- For the purposes of brevity, the masculine form has been used.

***Hypothetika*, the hypothetically speaking game!**

In science and technology, particularly in elementary school, the student must face a problem to be resolved or a challenge to overcome. In attempting to resolve the problem, the student will have to implement a process which implies, before moving onto action, the formulation of a hypothesis which will be verified afterwards.

For a child, or even for an adult, however, formulating a hypothesis is not always easy. In fact, though, it can be learned. Normally in science and technology in elementary school, it is while resolving problems of a scientific or technological nature that the student will begin to learn to do so. The game *Hypothetika* has been created to increase the number of occasions where the child can familiarise himself with hypothesis formulation and especially, with its justification.

In this guide, we present the game, its aims and rules, but also a theoretical capsule. The latter has been designed to help teachers accompany their students in learning how to formulate hypotheses.

Pedagogical aims

- Enable the students to familiarise themselves with hypothesis formulation
- Enable the students to practise scientific and technological justification and debate orally
- Enable the students to exercise their judgement in regards to scientific and technological justification
- Optional: enable the students to learn about writing a scientific or technological hypothesis.

Broad area of learning

Hypothetika may be associated to the Citizenship and Community Life Broad Area of Learning:

- Involvement in action in a spirit of cooperation and solidarity: principles, rules and strategies based on teamwork; decision-making process based on consensus, compromise, etc.; debate and defense of opinions; interaction with peers in a spirit of mutual help.

Targeted cross curricular competencies

- To solve problems: choosing solution trails
- To exercise critical judgement: to form an opinion, to express his/her judgement, to qualify his/her judgement
- To use creativity: to become familiar with all the elements of a situation, to imagine ways of proceeding
- To construct his/her identity: to be open to his identity, to become aware of his place among others, to make good use of his personal resources

Competencies in science and technology

- To propose explanations for or solutions to scientific or technological problems
- To make the most of scientific and technological tools, objects and procedures
- To communicate in the languages used in science and technology

Knowledge from the Progression of Learning

The objective of *Hypothetika* is not to develop the knowledge from the *Progression of Learning in science and technology in elementary school*. The statements on the *Hypothetika* game are, however, related to the progression:

- Level 1: 1st cycle
- Level 2: 2nd cycle
- Level 3: 3rd cycle
- Level 4: outside the program (to come)

The objective of the game

- The student must acquire the five (5) scoring pieces to win a game. Each scoring piece must be of a different colour.
- To win a scoring piece, the student must formulate a hypothesis that the other players judge is adequate in relation to a constraint corresponding to the square that they're on. In his justification, the student must use one of the following elements:
 - A reference to a measurement (length, thickness, surface, volume, temperature, time, mass);
 - A reference to a direct observation, related to a sense (sight, hearing, touch, smell, taste);
 - A reference to an observation assisted by an instrument (stereo microscope, microscope, telescope, binoculars);
 - A reference, by comparison to an object, a living being and to their operation;
 - One free choice. This reference could also be creative, off-the-wall, purely an invention¹. The other players must, however, agree with the idea.

The materials

- The game board
- A die (or a wheel of fortune²)
- *Hypothetika* game cards
- The four (4) constraints cards: one per player.
- Four (4) pawns: one per player.
- Scoring pieces: *Lifesavers*, buttons or pieces of five (5) different colours.
- The hypothesis sheet (optional)

¹ The use of this type of reference is related to:

- The possibility, for a student who is unlucky, of being able to move his pawn forward;
- The opportunity for the student to let his inventive spirit and creativity flow.

² The wheel of fortune could have been made ahead of time by the students.



Number of players

- Two (2) to four (4) players
- It is possible to play with more than four (4) players, but the game would be longer.

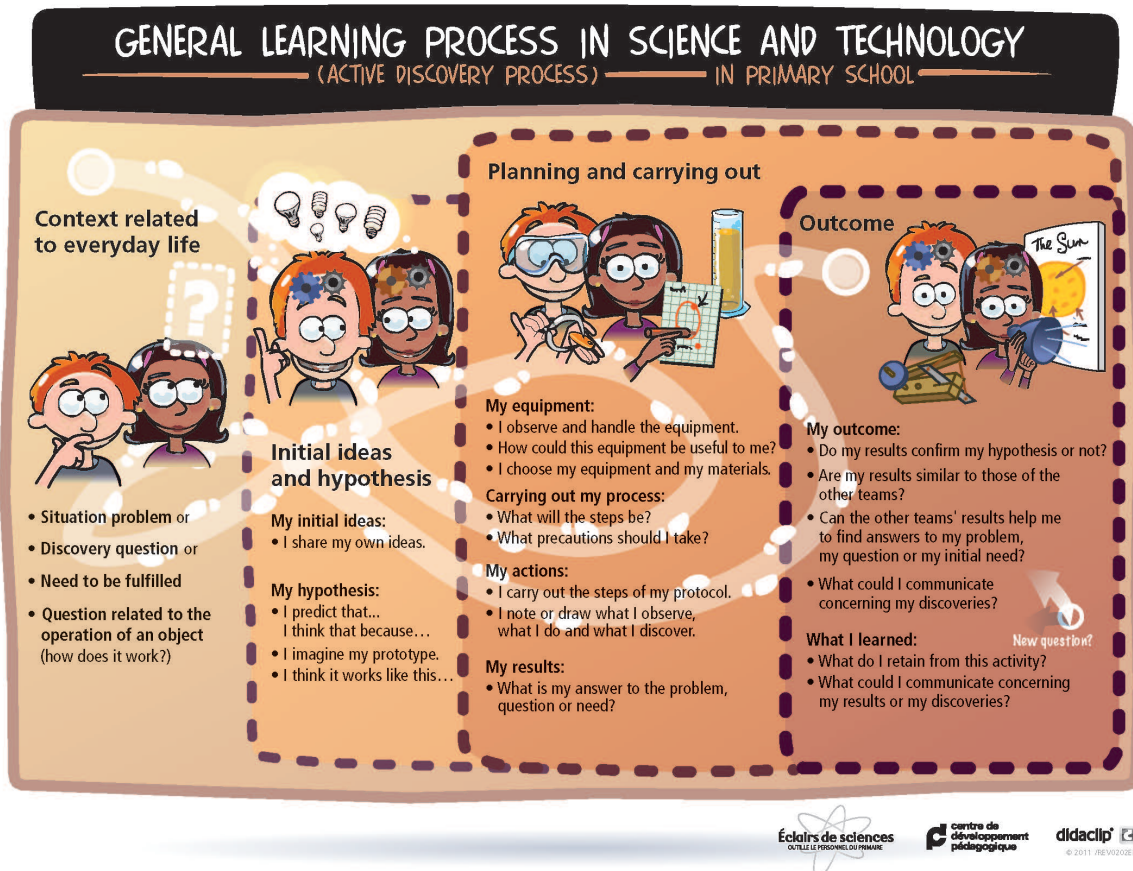
The rules of the game

- To start, each player rolls the die (or spins the wheel). The player that gets the highest value is the 1st to play.
- Each player's pawn is placed on the game logo at the bottom left.
- The first player rolls the die (or spins the wheel) and moves the number of steps (squares) equivalent to the value.
- The player takes a *Hypothetika* game card. He must then formulate a hypothesis taking into account the constraint associated to the colour on the card. He must also justify his hypothesis using a relationship marker (because, since, due to).
- If a majority of the other players judge that his hypothesis is valid and respects the constraint, the player receives a scoring piece. The piece matches the colour of the constraint.
- Each player gets a turn to roll the die, move their pawn and formulate a hypothesis.
- If the pawn falls on a square with another player on it, he skips his turn.
- To win the game, a player needs five (5) scoring pieces of different colours.
- During the game, the students must be attentive, rigorous and fair in their judgement. An unresolved conflict between players and requiring an adult's intervention will result in the players involved losing a scoring piece.

A hypothesis is not THE right answer to the question.

It is a tentative statement to be experimentally tested.

Theoretical capsule designed for teachers
Hypothesis, prediction, supposition, initial ideas and pre-conceived notions



First, we invite teachers to view the CDP animation about the general learning process in science and technology, available at the following address:
http://www2.cslaval.qc.ca/cdp/UserFiles/File/previews/general_process/, the section about initial ideas and hypotheses.

It is important to mention that there are numerous definitions of what exactly a hypothesis is. There are also any number of opinions as to what an elementary school student can state as a hypothesis. Some believe that it is impossible for a child to state a real hypothesis, while others have a more subtly shaded opinion.

As a tool, *Hypothetika* allows us to avoid this debate. Rather, the game aims to begin a learning process that will take place over a number of years for the students. It also aims to provide better tools for teachers who must respect the training program, the progression of learning and the evaluation framework. Teachers are, in fact, often without the necessary resources to support students as far as formulating a hypothesis is concerned.

Hypothesis

One definition:
 "A tentative proposal put forward with the intention of being experimentally verified."

Vocabulary for hypotheses

A large number of terms, of which the student must be aware, gravitate around the word hypothesis. The list below is not exhaustive, but suggests a directory of words that in most cases may be presented to elementary school students.

- Because, since, due to
- Confirm, refute
- Debate, to debate
- Explain
- Hypothesis
- Justify
- Prediction, to predict
- Proposal, to propose
- Tentative, tentatively
- Validate

Hypothesis and initial ideas: differences and similarities

First, we have to remember that there are several trains of thought about hypotheses, initial ideas, pre-conceived notions and everything that surrounds the beginning of a problem-solving process in science and technology. The objective of the avenues suggested in this document is to support a context for learning in science and technology in elementary school.

The initial idea is often intimately related to the initial conception, correct or otherwise, that the student has of a scientific or technological concept associated to the task he will have to carry out. The initial idea may also be the only thing the students suggests to resolve the problem of a scientific or technological nature, which has a good degree of openness and for which it will be necessary to isolate experimental factors more explicitly.

Hypothesis

Another definition: "A hypothesis is an explanation that can be tested." (Translation from Thouin, 2001, p.8)

As to the hypothesis, it should be directly linked to the problem to be resolved or the challenge to be taken up for which the student will implement a process afterwards. Optimally, elementary school students' hypotheses should contain a statement concerning a single experimental factor that the student can use for a scientific experiment. In a context relating to technology, particularly in design, the hypothesis is the first design idea the student thinks up. Often, it will then be represented using a sketch, a drawing or a descriptive text.

Within the framework of the general learning process in science and technology in elementary school, we suggest you distinguish between the hypothesis and the initial ideas. This being said, some tasks make this distinction difficult. Sometimes the problem submitted to the students is so closed-ended that the initial idea and the hypothesis will be identical. For example, when we ask 1st cycle students to choose which fabric, between a black one and a white one, will be more comfortable on a hot, sunny, summer day, the initial idea and the hypothesis will be close to the same statement.

In an LES, depending on the described context (the question suggested, the object to be designed or explained) and the problem to be resolved or the challenge to be taken up, the student may have some difficulty imagining a means to experimentally verify or to suggest a first design idea based on something other than his own personal initial ideas. Also, his arguments may pertain more to planning his process rather than to an explanation which answers “why do I think that” or to “why I would think to respond to the need in this way”. **In complex tasks submitted to the students, it is therefore important to suggest a context that lends itself to answering appropriately if we want them to work on this aspect of the process.**

Table 1 – Initial ideas and hypotheses: a few similarities and differences

Similarities	Differences
<ul style="list-style-type: none"> Both are considered to be tentative explanations. In certain tasks or problems, the initial idea and the hypothesis may be the same tentative proposal. In that case, it is unnecessary to require the student to leave traces for both. 	<ul style="list-style-type: none"> The expression “initial idea” is a plain language term for students, meaning the initial concept that the student has of the studied notion. In complex tasks submitted to students in science and technology in elementary school, the hypothesis is directly linked to the problem the student must resolve. For a complex task, it is possible that several concepts will be addressed. It is thus possible to issue initial ideas about all the concepts which lend themselves to it. When the problem or challenge lends itself to it, we suggest that you associate “initial ideas” to the more “open” part of the problem that the student must resolve and the “hypothesis” to the more closed dimension of the same problem. Thus, the elementary school child will more easily issue his hypothesis and justification thereof.

Expressing and writing a hypothesis

In elementary school, the student begins learning to *write varied texts*, one of the competencies of the Language Arts program. In parallel with learning to write, he also learns to better *communicate orally*. The game of *Hypothetika* can exploit these two competencies in a fun, different context from what is normally done in class.

Stating and justifying a hypothesis is, however, a high level task for elementary school students. To manage to do so, the student must juggle a great deal of knowledge and many abilities both in terms of mastering language and in science and technology. Some form of training will help the child become more proficient in doing so. The game of *Hypothetika* therefore offers students the opportunity to practise stating hypotheses.

Hypothetika may be played independently, purely for pleasure. It may moreover be of value to use the pretext of the game to target certain knowledge acquisition, or to reinvest previously acquired knowledge. Here are some examples:

- Anything that concerns relationship markers allowing a causal link between the hypothesis and its justification (because, since, due to).
- Anything that concerns verbs that may be used to express a hypothesis:
 - Propose, predict, believe, etc.
 - Distinguish between the meanings of these verbs
- Everything pertaining to the cause and effect of phenomena. It would therefore be of value to make sure the students understand what causes a phenomenon and what its effect may be.

Thus, as a complement to the game, we propose a hypothesis work sheet where you may ask the student to write the hypotheses that were accepted by their peers. This worksheet will enable you to review the strategies adopted for issuing a valid hypothesis and certain elements for writing such a hypothesis. It is nonetheless recommended that you use this worksheet sparingly, in order for the game to retain its fun factor and to allow the activity to flow well.

Proposals for animation before, during and after playing Hypothesika

Game rules for *Hypothesika* are relatively simple and similar to those of many other board games. The student who is somewhat used to board games should therefore easily find his way around the game.

Learning to formulate a hypothesis

The main element we will work on with the students will certainly be related to formulating proper hypotheses. This will enable them to judge whether or not a hypothesis is up to standard. In fact for the majority of students, this element is essential before beginning the game. This type of task is not instinctive, however, and must be learned. Here then, are some avenues to model what the expectations are:



1. Hypothesis models: the TV show *Génial!* on Télé-Québec

This TV show essentially revolves around three (3) hypotheses which are debated, then tested experimentally. The hypothesis is justified by the participants when they try to make their decision.

It may be possible to watch a show or part of a show, in order to present to the students what a hypothesis should sound like.

2. The team game: a preliminary, or complement to, independent playing.

You may choose to play a few trial rounds, asking teams of four (4) students to try to formulate a hypothesis based on a card chosen at random, accompanied by a constraint, also chosen at random. All the teams attempt to formulate a hypothesis about the same initial situation.

During a group round-table, it will then be possible to discuss what made a hypothesis valid or not. This way, there is a common understanding of what is expected.

3. Examples of hypotheses: some models

Finally, it is also possible to provide a model for the students, with examples of valid hypotheses. To do so, it may be appropriate to develop a variation on the game, suggesting hypotheses. Then, ask the students to judge the conformity of the hypotheses and to associate them to the appropriate constraint.

Provide feedback after a few rounds of play

After having played a few rounds of the game, it would be of value to ensure that the students are beginning to better distinguish a proper hypothesis from one that should not be retained. The student (or team) may then use the hypothesis work sheet to write one or more hypotheses

New words

Whether it be before, during or after playing *Hypothetika*, the student may come up against words he did not previously know. It may also be that he will need new or more precise words, to better express what he is thinking.

It is thus recommended that you note newly learned or previously little known words. How traces of these new vocabulary words are kept may vary, depending on what is already in place in class for language arts or mathematics.

The temptation to provide the “right” answer

At any given time, you need to remember that the hypothesis is a **tentative** explanation which will be subjected to experimentation in order to confirm or refute it. It is therefore not "the" right answer to the question or problem with which we will work.

It is therefore essential to remind the students of this fact to avoid the adult reflex which leads them to suggest the right answer to the question or problem. At all times, you need to remember, and to remind the students, that a good hypothesis may be refuted and that this will not be considered a “mistake”. In fact, it is even positive to face hypotheses which will be refuted, since then, it is certain that the question or problem is leading to real learning rather than to a review of something which is already known.

On this subject, we recommend reading, in part or in its entirety, the book *L’erreur, un outil pour enseigner* by Jean-Pierre Astolfi, whose 6th edition was published by chez ESF éditeur in 2004.

Complementary references

Astolfi, Jean-Pierre (2004), *L'erreur, un outil pour enseigner*, 6^e édition, ESF Éditeur, Collection Pratiques & enjeux pédagogiques, Issy-les-Moulineaux.

Centre de développement pédagogique

General Learning Process in Science and Technology in elementary school
http://www2.cslaval.qc.ca/cdp/UserFiles/File/previews/general_process/

Génial! – Televised game show

Télé-Québec
<http://genial.telequebec.tv>

Ministère de l'Éducation, des Loisirs et du Sport (MELS)

Progression of Learning in Elementary School - Science and Technology – Strategies section
[http://www.mels.gouv.qc.ca/references/publications/resultats-de-la-recherche/detail/article/quebec-education-program-progression-of-learning-in-elementary-school-science-and-technology-1/?tx_ttnews\[lang\]=1](http://www.mels.gouv.qc.ca/references/publications/resultats-de-la-recherche/detail/article/quebec-education-program-progression-of-learning-in-elementary-school-science-and-technology-1/?tx_ttnews[lang]=1)

Framework for the Evaluation of Learning in science and technology in elementary school
https://www7.mels.gouv.qc.ca/dc/evaluation/index_en.php?page=search

Thouin, Marcel, *Enseigner les sciences et la technologie au préscolaire et au primaire*, Éditions Multimondes, Sainte-Foy, 2004.